SEVEN POINT ACTION PLAN FOR MALARIA CONTROL IN MADRAS CITY

MALARIA RESEARCH CENTRE
22-SHAM NATH MARG
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7-Point Action Plan for Malaria Control

Madras city is endemic for malaria and cases of drug resistant *P. falciparum* malaria have been recorded. Focal malaria outbreaks are often encountered and the problem of urban malaria in Tamil Nadu is of long standing. It may be pointed out that Madras city alone contributes 50-70% new malaria cases annually to the malaria problem of the state (Fig. 1). The vector *Anopheles stephensi* responsible for malaria transmission in Madras city breeds in clean stored water such as in the overhead tanks, cisterns and wells. Tables 1 to 2 give epidemiological picture of malaria in Tamil Nadu and Madras.

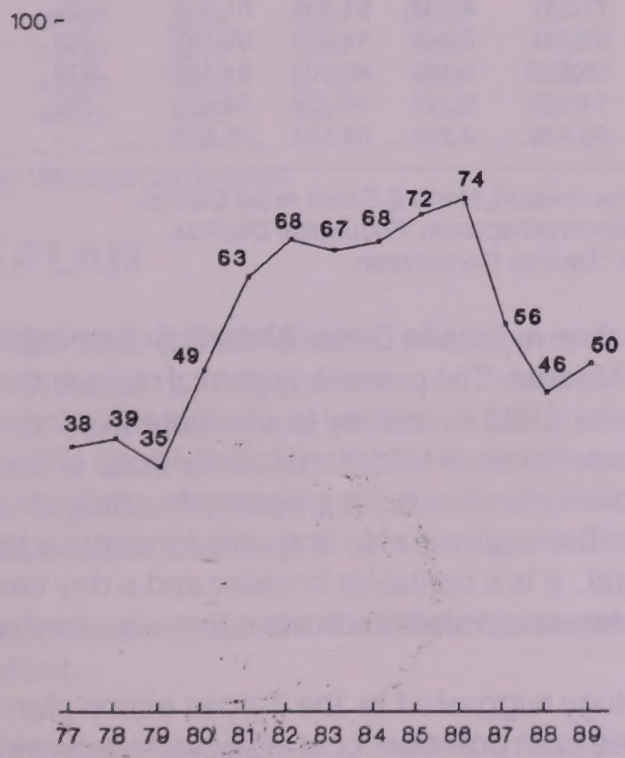

Fig 1:Percentage of malaria cases indigenous to Madras city in the state of Tamil Nadu.

TABLE 1 : INCIDENCE OF MALARIA IN TAMIL NADU

Year	TAMIL NADU		URBAN MALARIA			
	No. of cases	*P.falci-parum*	Ten Urban Centres	Madras City	Riverine area [x]	Coastal area [xx]
			No.of Cases	No. of Cases	No.of Cases	No. of Cases
1977	79,537	2,094	-	28,437	-	-
1978	76,227	1,512	-	29,953	-	-
1979	95,009	3,312	-	33,450	-	-
1980	73,381	2,802	42,661	36,193	-	-
1981	71,517	2,531	50,742	44,951	-	-
1982	65,797	3,048	47,840	44,981	-	-
1983	67,192	4,481	47,796	44,817	-	-
1984	71,320	4,724	51,839	48,523	1835	8164
1985	71,347	4,303	54,795	51,376	1426	6726
1986	52,741	2,848	44,852	39,197	883	3988
1987	55,523	3,588	40,400	31,126	678	4661
1988	74,303	5,214	44,734	34,400	725	16322
1989	90,478	4,244	64,584	45,622	-	-

(x) - Dharamapurl, North & South Arcot District.
(xx) - Ramanathapuram, Pudukottai Districts.
Source : Madras Corporation.

For more than a decade Urban Malaria Scheme (UMS) is under operation in Madras. The present system of malaria control as practiced under the UMS is unlikely to eliminate this focus. Based on the MRC's experience of field work in 6 divisions of the Corporation a 7-point action plan has been prepared to eradicate malaria from Madras city. The region is also endemic for dengue transmitted by *Aedes aegypti*. It is a container breeder and a day biter mosquito. The action plan would also eradicate dengue as a collateral benefit.

The strategy suggested in the 7-point action plan is simple, indigenous, free from pollution, cost effective and provides long term control of the vector borne diseases.

TABLE 2 : EPIDEMIOLOGICAL DATA OF MADRAS CITY

Year	No. of cases	Pf +ve	% Pf	API	ABER	SPR
1973	617	-	-	0.27	-	-
1974	2560	136	5.31	0.96	2.3	1.26
1975	36207	482	1.33	13.28	9.3	12.99
1976	40623	388	0.96	14.54	8.7	14.68
1977	28437	297	1.04	9.93	9.4	9.34
1978	29953	242	0.81	10.42	9.7	9.67
1979	33450	124	0.37	11.58	8.8	12.86
1980	36193	189	0.52	11.65	6.7	16.16
1981	44951	830	1.85	13.73	8.9	13.83
1982	44981	1673	3.72	13.41	9.2	12.06
1983	44817	2971	6.63	12.98	10.4	10.58
1984	48523	3358	6.9	14.72	9.4	12.36
1985	51376	3185	6.0	15.68	12.6	10.47
1986	39197	2608	6.65	10.59	13.1	7.03
1987	31126	2218	7.12	8.28	16.0	5.20
1988	34400	1982	5.76	8.46	13.98	6.05
1989	45622	2542	5.57	11.4	15.1	7.50

Source : Madras Corporation.

ACTION PLAN

1. ACTION BY THE GOVERNMENT: An appropriately worded Government Order (G.O.) may be issued to the following agencies responsible for construction and maintenance of all buildings including defence and railways, State Government buildings, autonomous organizations, educational institutions and all industrial houses, public buildings & other institutions etc.

The above agencies must observe the following responsibilities with immediate effect.

Mosquito proof all water storage overhead tanks (OHTs), cisterns and wells. Water should not be allowed to leak from pipe lines, taps

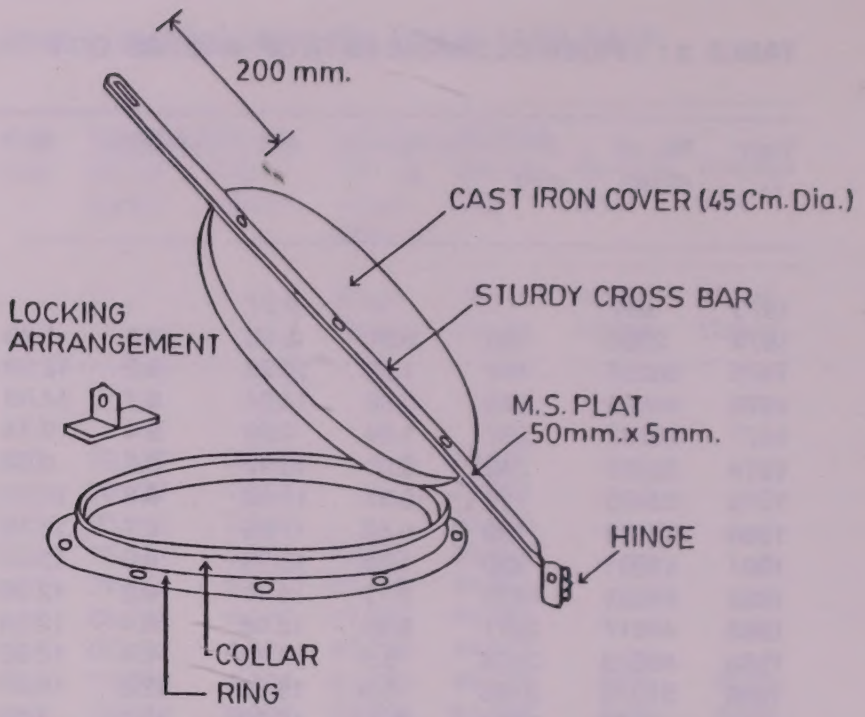

Fig. 2 : Standard design of a cover to be used for mosquito proofing of OHT, Well or a Cistern.

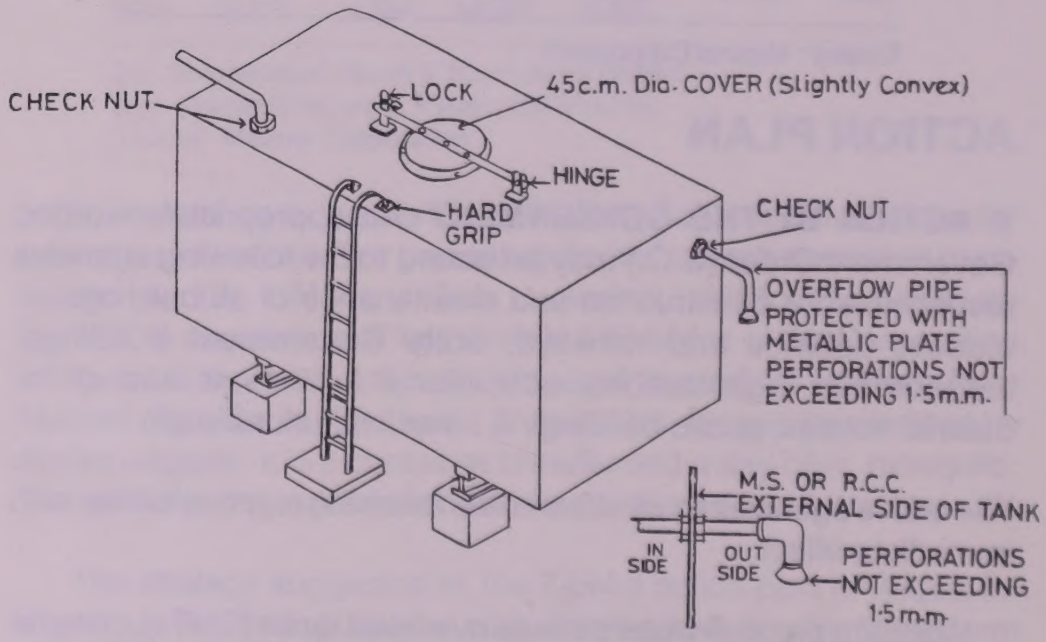

Fig. 3 : Standard design of over head tank.

etc. and proper drainage must be maintained. Water coolers and air conditioners etc. should be cleaned at least once a week to eliminate standing water.

No further installation of OHT's cisterns should be allowed & wells permitted unless they are mosquito proofed. (See Fig. 2: Standard design of a cover to be used for mosquito proofing OHT, well or cistern etc., Fig. 3: Recommended design of mosquito proofing OHT, Fig. 4: Recommended design of mosquito proofing a well).

One officer in each building/institution should be designated for vector control work and given full responsibility to ensure that there is no mosquito breeding in his buildings. His name should be communicated to the Corporation as a contact person for interaction and inspection. He should be allowed adequate budget for vector control work and made fully accountable. Expenditure towards this activity should preferably be met from the budget of the respective organisation/institution.

The Government should also ensure the following :

(i) Technology for mosquito proofing of the wells, OHT's/cisterns should be made available easily through pamphlets, media etc. It would also be advisable to ensure the availability ready made mosquito proof OHT's/cisterns etc. in the open market for installation.

(ii) Provision of loans (preferably interest free) should be made through banks or corporation to avoid hardships in the mosquito proofing of water storage facilities. Recovery of loans should be made in easy instalments.

(iii) A source for the supply of larvivorous fishes & expanded polystyrene (EPS) beads should be identified and given due publicity.

(iv) Larvicidal oil should be available in the open market in tins for use by the contractors (at present it is a govt. supply).

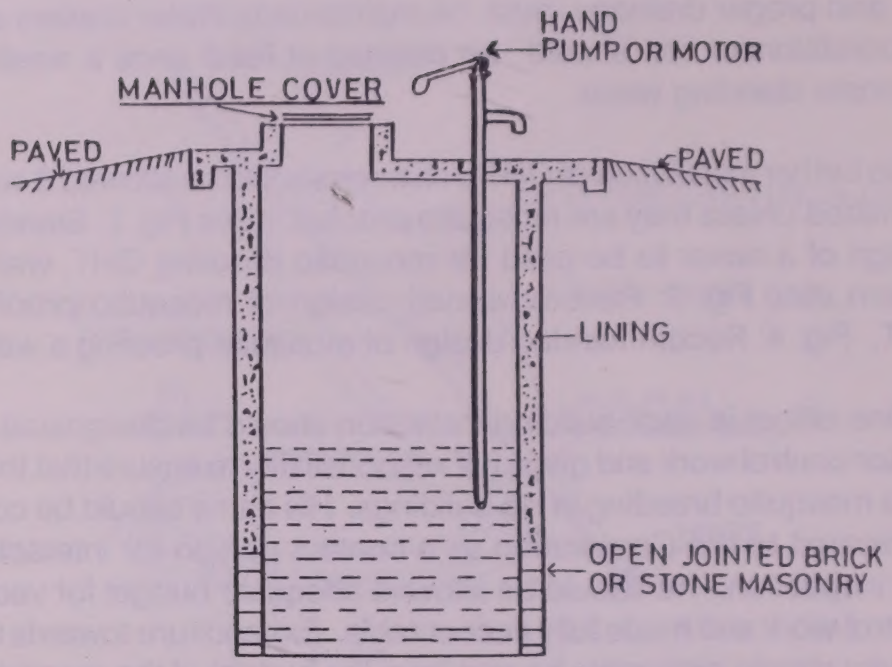

Fig. 4 : Standard method of mosquito proofing a Well.

The label on the tin should provide full instructions on its method of application.

A similar action of mosquito proofing of OHTs/cisterns and wells should be adopted in all colonies/divisions of the Madras city. In order to implement the strategy health department/corporation should elicit people's participation, involve health education bureau, prepare educational material and make full use of media. The health department should also involve voluntary agencies, non-governmental organizations (NGOs), students, Mahila Mandals and other action groups in whatever manner possible in dissemination of activities of the action plan for mosquito control and solicit positive support through individuals and joint action (e.g., shram dans etc.) for the preventive and corrective aspects of mosquito breeding.

It may be noted that main mosquito breeding sites of malaria vector *Anopheles stephensi* are OHTs and wells followed by cisterns.

Mostly *Aedes aegypti* (also known as container breeder) breeds in cisterns. This is a day biter mosquito. The vector is responsible for dengue outbreaks and during 1989 there were cases of dengue haemorrhagic fever in Madras.

A major activity of health department would be to identify all mosquito breeding sites (geographical reconnaissance) and prepare action plan for the control of mosquito breeding for each habitat. In this activity health department would be required to solicit help from other departments/agencies. Follow up action, persuation, providing technical guidance and monitoring would be an important function of the health department which must be planned and executed meticulously.

Early case detection through passive agencies activated , passive agencies, mass blood surveys, rapid blood smear examination and administration of presumptive and radical treatment must be ensured. In certain high transmission areas malaria clinics may be opened and given full publicity.

2. INTER AND INTRA-DEPARTMENTAL COORDINATION : Health department of corporation/municipalities in consultation with the state health department should be responsible for coordination of vector control work in the city. In that capacity they would be required to solicit from their own and other departments/agencies their active participation in preventive and corrective aspects of mosquito control. Some Govt. Departments must participate in malaria control programme directly. For example water supply department must ensure that water pipes/lines are well protected and not damaged and there are no leaking water taps or pipelines. All leakages/damages should be repaired on priority basis within 24- 48 hours and stagnant water drained. Sewage and storm water pipes should be well maintained and cleaned as and when due. All manhole covers should be repaired and properly installed to prevent mosquito emergence. Similarly ventilating shafts should be mosquito proofed. Horticulture department must ensure

that no mosquito breeding occurs in stagnant water in gardens, parks, and ornamental fountains etc. The Fisheries department must ensure clear shore line of the ponds and other water bodies and survival of larvivorous fishes in all water bodies. All Govt. engineering departments must ensure prevention of water stagnation, adequate drainage and if stagnant water is required for some activity it should be suitably treated to prevent mosquito breeding.

Health department should elicit people's participation and involvement in mosquito control through educational programmes and they should make full use of media in achieving this. School/College students and voluntary agencies should be mobilised in preventing the mosquito breeding.

It may be pointed out that in certain parts of Madras city there is acute shortage of water and people belonging to low socio-economic status are worse hit. In such localities water lines are damaged or public water facilities are mis-used. Government must ensure proper water supply in such areas before initiating action to repair the damage or stopping water supply to such localities.

3. LEGISLATIVE MEASURES : Municipal bye-laws must be implemented rigidly and defaulters punished. Bye-laws in Madras have been amended recently for this purpose. For the effective enforcement of provisions under the Public Health Act and Madras City Municipal Corporation Act, the Assistant Entomologists may be empowered to issue notices and institute prosecution proceedings with the prior approval of the concerned Senior Entomologist. The fine to be imposed to the defaulters should double up every time with non-compliance. The Government of Tamil Nadu may be requested to bring suitable amendment to the Act.

4. CLEARANCE FROM HEALTH DEPARTMENT: New constructions should be permitted only after obtaining permission/clearance from the Health Department/Corporation of Madras and it should be made compulsory for the owners to deposit the expenditure to be incurred for undertaking anti-mosquito measures in their

premises. The Health Department/Corporation of Madras should decide on the amount to be deposited, for undertaking preventive/remedial measures, depending upon the potential breeding sources and duration of water storage. No building plan should be cleared if it does not fulfill the conditions specified in the Public Health Act. In the ongoing constructions mosquito proofing of OHTs, cisterns and wells must be ensured, and help of bye-laws should be taken for compliance. It may be pointed out that this procedure is currently followed by the Bombay Municipal Corporation and there are no protests or complaints in the implementation of this system.

5.TROPICAL AGGREGATION OF LABOUR : A large number of agencies are constantly engaged in construction work all over the township. It has been observed that tropical aggregation of labour for construction is often the primary cause of the establishment of foci resulting in outbreaks of malaria. It is therefore absolutely essential that (i) Incoming labour is screened for malaria infection and given radical treatment, and (ii) all construction sites are made free of mosquito breeding. In order to achieve this objective construction companies/contractors must take help of health department and ensure that water is not allowed to stagnate. All standing water whether for curing or construction work must be treated with chemical larvicides like Baytex or Abate or MLO. In certain situations like big water reservoirs Gambusia (*Gambusia affinis*) fishes should be introduced. In polluted waters Guppy (*Poecilia reticulata*) fishes may be introduced. There should be regular inspection of all sites and preventive measures of mosquito breeding applied rigid ly as soon as any standing water is found.

It would be advisable to include the preventive aspects of mosquito control in the contract itself. Government may therefore issue appropriate instructions to all departments for such action. Failure to maintain the site free of mosquito breeding should attract prompt action under the bye-laws. It is noteworthy to mention that this is a fairly easy and inexpensive method of malaria prevention, and if implemented properly it works wonderfully well.

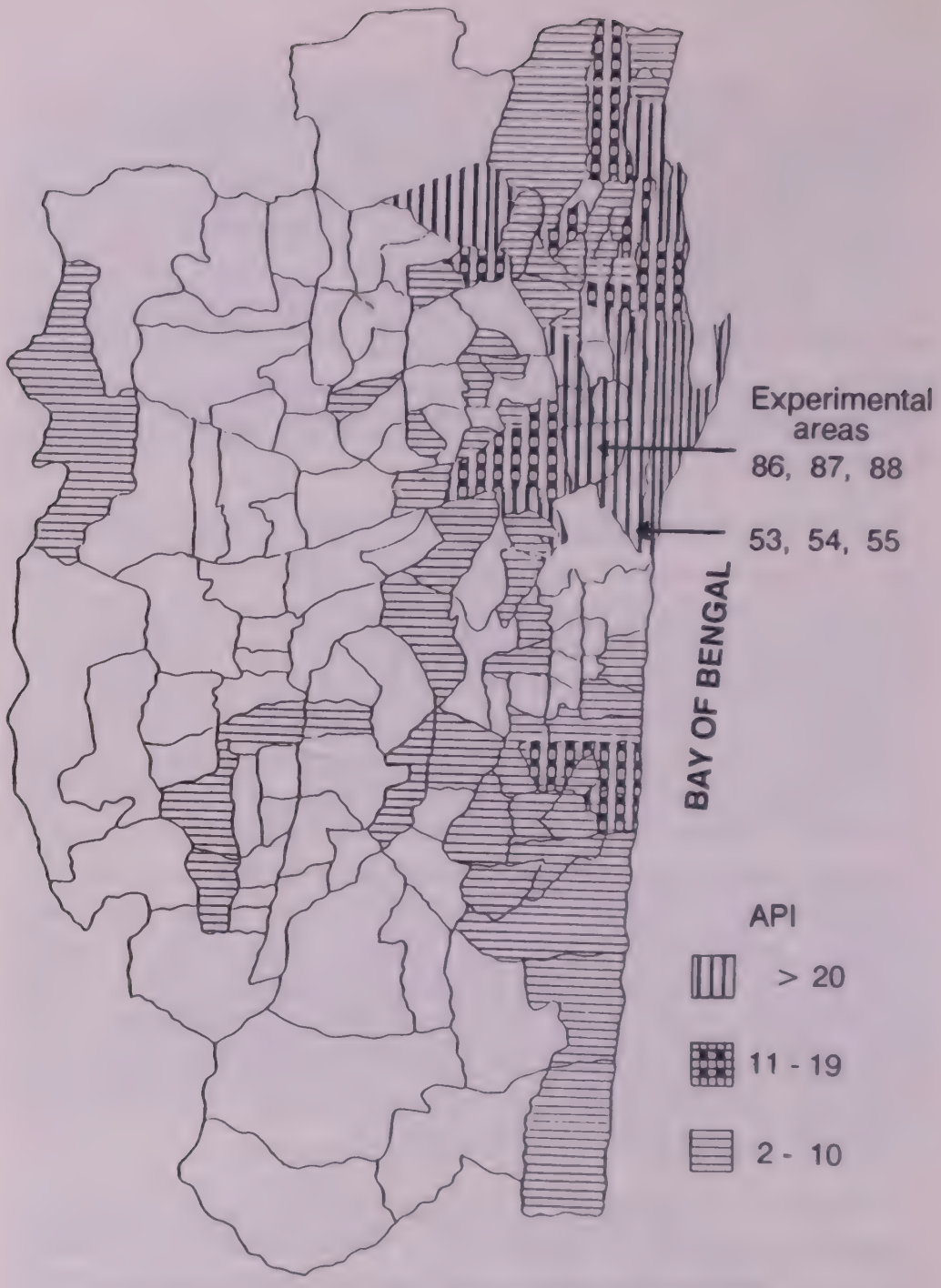

Fig. 5 : Madras : The city is divided into 150 divisions. Figure showing the stratification of divisions according to 1988 API. Also shown are 6 divisions under bioenvironmental control strategy implemented by the Malaria Research Centre.

In areas of large populations of migrant labour one time screening of labour and radical treatment of those found with malaria parasite may be undertaken by the health department.

6. IMPLEMENTATION MECHANISM : The work should be started in phases as indicated below :

Phase-I (six months)

i) Map all mosquito breeding sites. This information is already available and may require minor changes/updating.

ii) Implementation of bye-laws.

iii) Government order should be issued to all Govt. and non-govt. agencies and other organizations as indicated under item 1.

iv) Six divisions at present under the MRC should be taken up (Divisions 86, 87 & 88 and 53, 54 & 55). See Fig. 5.

v) Fish multiplication ponds (for Gambusia and Guppy) should be established in as many water bodies as possible.

vi) Ensure the availability of EPS-beads and availability of mosquito proofing devices.

Phase-II (six months)

All high incidence divisions (20 API) should be taken up. See Fig. 5 (i) Stratification of Madras city according to API and (ii) areas currently under the bioenvironmental control strategy i.e., Divisions 53, 54, 55, 86, 87 & 88.

Phase-III (six months)

The entire Madras city may be included. See Figs. 6, 7 and 8: Major mosquito breeding sites of *Anopheles stephensi* (vector of

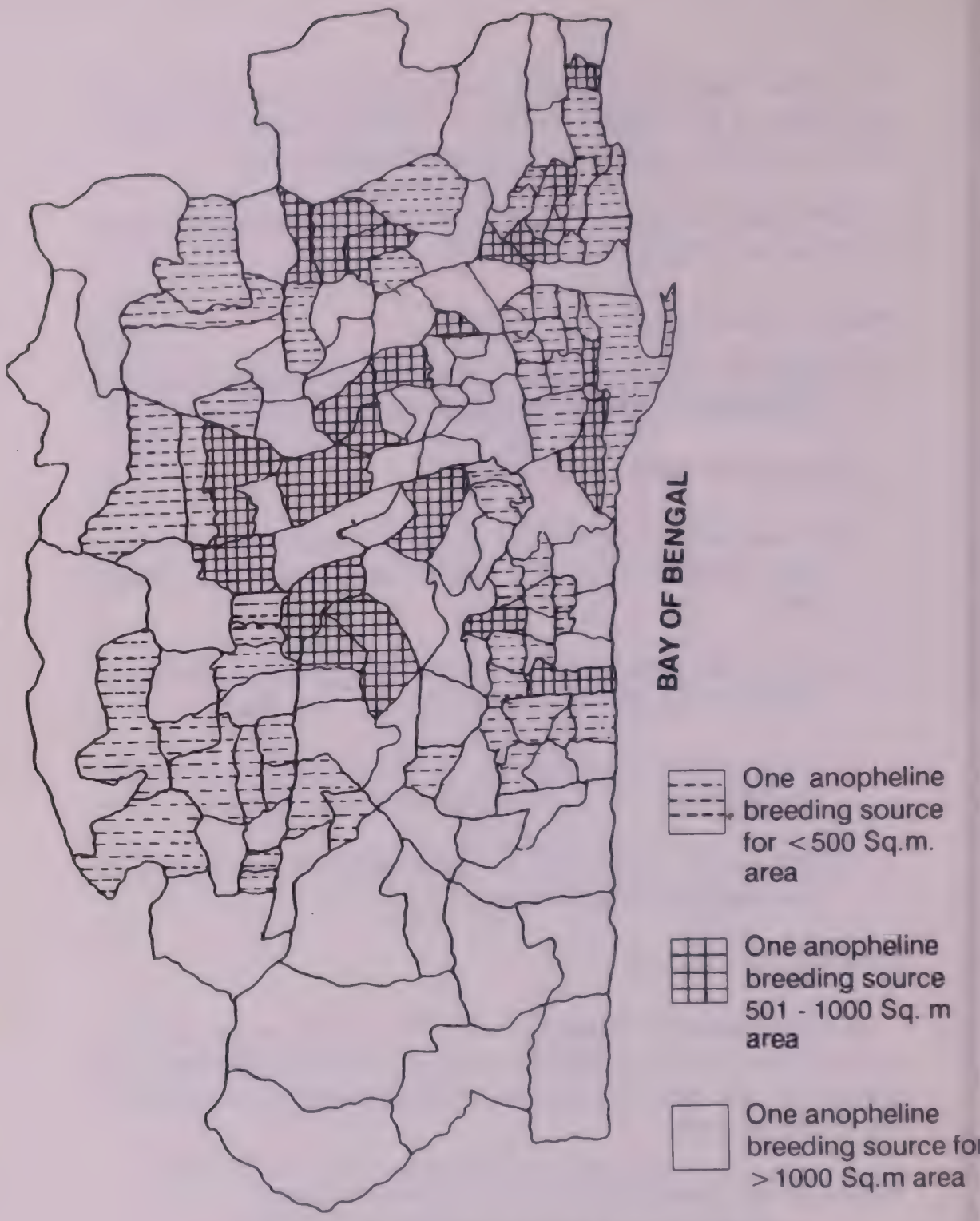

Fig. 6 : Madras : Anopheline breeding potential in the city (Source : Madras Corporation).

malaria), *Aedes aegypti* (vector of dengue) and *Culex quinquefasciatus* (vector of filariasis and a mosquito of high nuisance value).

Adoption of above methods will result in almost complete interruption of malaria transmission and also cases of dengue fever (Tamil Nadu is endemic for dengue) would cease to occur. Mosquito nuisance will also be curtailed to a very large extent. Control of *Culex quinquefasciatus* the nuisance tropical house mosquito and the vector of filariasis (*Wuchereria bancrofti)* would require major environmental modification works which could be taken up at a later stage.

7. CONSTITUTION OF COMMITTEES : The 7-point action plan may be monitored through a steering committee responsible for ensuring continued government and political support and a project committee to oversee the implementation and monitor its progress. The membership to the committees may be finalised by the Government of Tamil Nadu. The following compositions are suggested

(i) A steering committee which would be an apex body may be constituted to steer the project at the Government, political and community level. The committee could be chaired by an eminent scientist of international repute. The committee should have nominees of the Chief Minister, NGO, a social worker, Director MRC and chairman of the project committee and any other member co-opted by the Chairman. This committee would be responsible for obtaining whole hearted support of the politicians and the government and mobilise community's involvement and participation. The committee will also help in removing bottlenecks and ensure adequate funds. This committee would meet atleast once in six months.

(ii) A Project Committee may be constituted with the Chief Secretary as Chairman to evaluate overall perforance of the project and to remove bottlenecks. The committee may comprise of the Secretaries of the Department of Health & Family Welfare, Urban Development, Chief Engineer Public

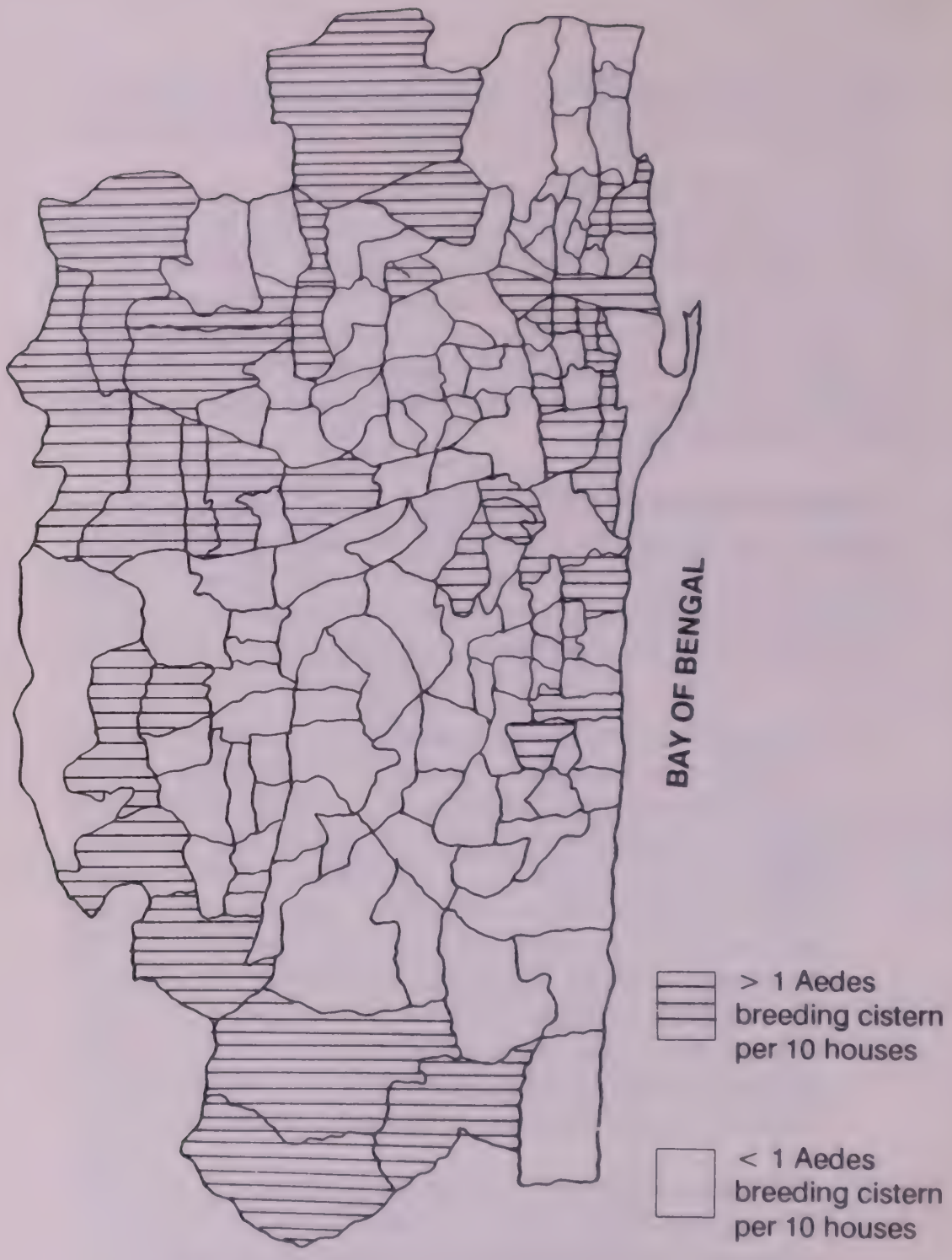

Fig. 7 : Madras : Aedes breeding potential in the city.
(Source : Madras Corporation)

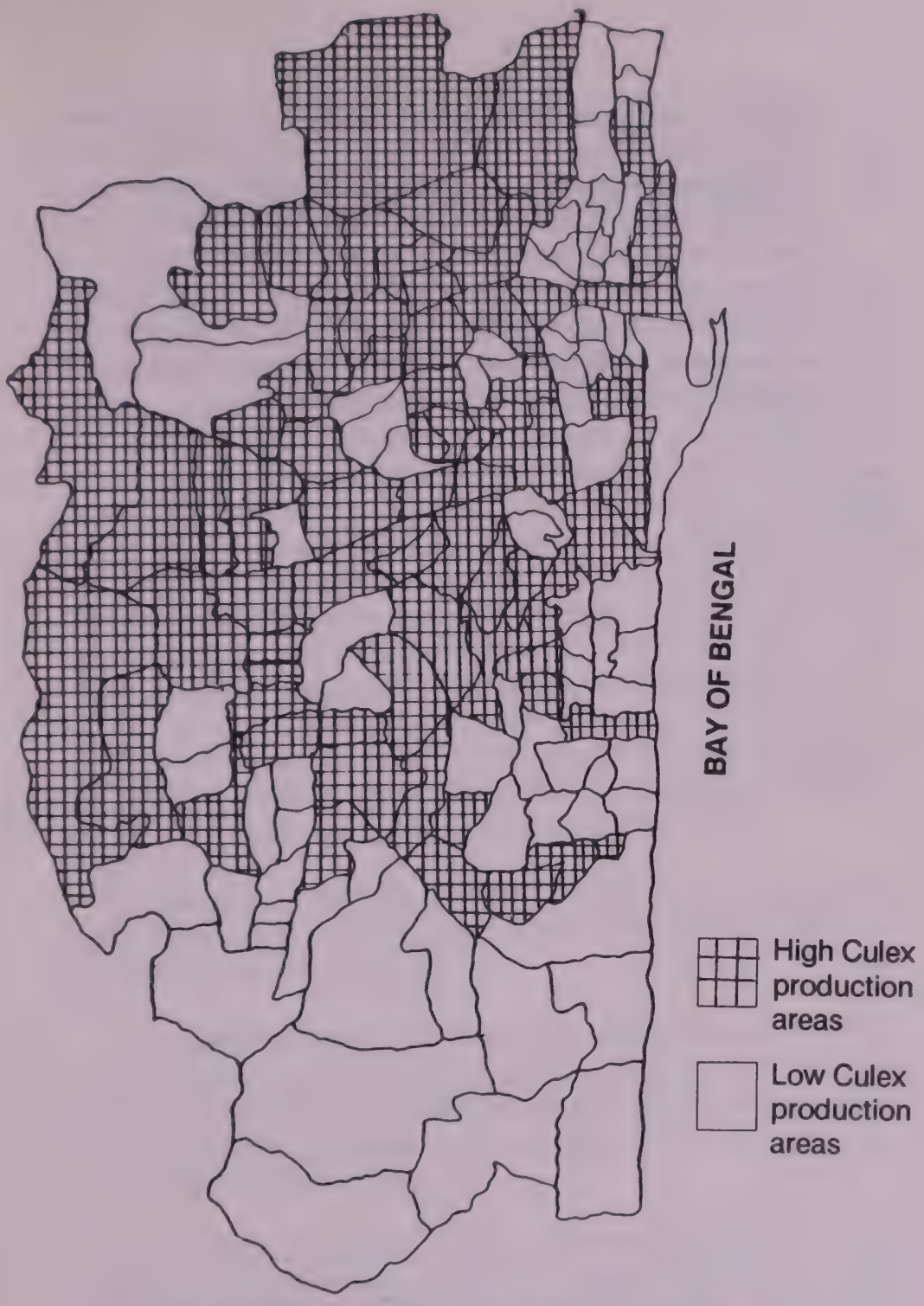

Fig. 8 : Madras : Culex breeding potential in the city. (Source : Madras Corporation).

Works Department (PWD), Central Public Works Department (CPWD) and Local Self Government. The Director and Additional Director (Malaria), and Chief Entomologist, Directorate of Public Health & Preventive Medicine. Special officer, Commissioner(Health) and Health Officer, Madras Corporation, nominee of the Director MRC, Representative of Railways, Defence and two nominated members from social organizations and any other member co-opted by the chairman. The committee should meet at quarterly intervals.

This action plan can be adopted to almost all urban areas with minor changes.

BACKGROUND INFORMATION

1. Introduction : Tamil Nadu is one of the four States of Southern Peninsular. The eastern face of the State touches Bay of Bengal and an alluvial plain runs along the coast. This is known as Coramandal coastal plain and extends to a width of about 80 km in some places. The coastal plain stretches for about 1000 km from the Pulicat lake to Kanyakumari. It is divided into three sections, the northern section of the Coramandal coast being 80-100 km wide with an average height of 75 m. The middle section comprises of the Cauvery delta and the southern sandy section and covers rest of the eastern coast. The entire coastal belt is generally deficient in rain fall. The strip of land along the coast is fringed with sand dunes and lagoons. To the West of Coastal plain of Tamil Nadu there are small or large chains of discontinuous hills such as Javadi, Shevaroy, Pachaimalai and the hills of Madurai district. The Nilgiris plateau rise abruptly from the low level country lying to the west and southeast of Karnataka plateau to an average elevation of 2440 metres.

The important rivers are Cauvery, Vaigai, Tambraparani, Palar and Ponnaiyar. The river Tambraparani is fed by both the South-east and north-east monsoon.

The state is under the influence of both South-east and North-east monsoon. However the coastal plain and the southern parts receive more rainfall in October-January than during the period from June-September. Average monthly temperature throughout the year remains above 21 deg. C.

The agricultural season extends to a period of 8 months, June to January in many districts. As this is meager rain fall area, people resort to irrigation by stored rain water in tanks. It is estimated that tanks irrigate about two-fifth of the total irrigated area. However, canal irrigation is extensive in the Cauvery delta.

2. Malaria : Tamil Nadu faces a trinity at present as far as malaria problem is concerned. The problem could be grouped under a) coastal malaria in the south-east coast including Rameshwaram island, b) riverine malaria in the riverine belt villages on the Pennaiyar river in Dharmapuri, North and South Arcot districts, and c) urban malaria.

The malariogenic stratification of areas in 1948 revealed that the hilly tracts of Dharmapuri, Coimbatore, Nilgiris, South and North Arcot districts of the state were hyperendemic while parts of Dharmapuri, South and North Arcot and Madurai districts were classified as potential epidemic areas, with variable degree of endemicity. Interestingly, the entire coastal strip was a healthy plain. Three vectors transmitted malaria viz., *A. fluviatilis* in the foot hills, *A. culicifacies* in the plains and *A. stephensi* in the urban areas.

However, between 1948 and 1958, a number of schemes were undertaken, specially after the commencement of the National Malaria Control Programme (NMCP) in 1952-53. These schemes were combined to form 2.7 units (one unit comprised of 1 million population). Another important development was that the urban malaria started increasing. As a matter of fact, during the NMCP period itself one urban unit started functioning which included the towns of Madras, Erode, Salem, Namakkal and Tiruppor. Total rural and urban units protected a population of 1.6 and 1.1 million respectively.

With the control measures undertaken following commencement of National Malaria Eradication Programme (NMEP) in 1958 there has been a change in the general epidemiological picture of the State over a period of about 2-3 decades. The disease has, at present established in the coastal strip which was virtually free from malaria earlier and many areas like part of Ramanathapuram and Rameshwaram island, have become receptive and vulnerable with active foci of the disease persisting. The regions in hilly tracts of the state which were earlier known to be hyperendemic have almost

become free from malaria. Urban malaria has become a major problem in Tamil Nadu. While *A. culicifacies* is the major vector of urban malaria in greater parts of the state, the influence of *A. fluviatilis* is restricted to the riverine belt and foot hill regions. Though *A. stephensi* is the major vector of malaria in towns, influence of *A. culicifacies* is also suspected, especially in the peripheral belt.

The centrally sponsored urban malaria scheme (UMS) extends to ten towns/cities in Tamil Nadu i.e., Madras, Salem, Rasipuram, Ellapatti, Tuticorin, Erode, Vellore, Trichi, Dindigal and Kumarapalayam. The incidence of malaria in the state of Tamil Nadu classified under the urban, coastal and riverine areas is presented in Table 1. Out of ten urban centres, the problem of malaria in Madras city is acute. The city has contributed about 46% to 74% of cases to the total cases recorded in the State.

The malaria problem in Madras city appears to be long standing. As early as 1912 - 15 larvivorous fishes were introduced into wells in George town as this happens to be a notorious area for malaria. Following the commencement of the NMEP during 1958-59, DDT spraying was undertaken in Adayar, Kilpauk, Royapuram, Tondiarpet, Perambur, Vadalipani, Sembiam, Vyasarpadi and Washermenpet which were at that time at the periphery of the city. Malaria was brought under control.

But, from the mid-sixties focal outbreaks were reported from construction sites in labour imported from Salem. In one such outbreak in Reserve Bank site 80 out of 200 Blood smears examined were found positive. Thereafter, the disease followed all major construction sites of the city. With the expansion activity of the city the incidence of malaria also increased and the areas classified as peripheral belt became malarious. With the extension of the city large scale construction activities brought in labour from different parts of the state, particularly from Salem and North and South Arcot districts which are known malarious areas. This facilitated in

the importation of gametocyte carriers (malaria cases). These workers instead of returning back, settled down in slums.

As a result slums started increasing day by day. At present, the city including the core city and extended areas is estimated to have 996 slums with 6.51 lakhs population. Out of these, 656 (65.8%) slums are in existence for more than 20 years. Slums have spread almost throughout the city, particularly on either side of water ways and main roads.

The city of Madras extends to an area of about 172 sq. kms with a population of about 4 million. Malaria is the major public health problem. The incidence of malaria from 1973 to 1989 along with other epidemiological data are given in Table 2.

The number of malaria cases recorded in Madras was 617 in 1973 and 2560 in 1974. But, during 1975 there was a sudden spurt in the incidence with as many as 36207 positive cases recorded demonstrating about 15-fold increase to the 1974 figures. During the period 1975 - 1984 the number of malaria positive cases fluctuated between 30,000 and 45,000. Peak incidence was recorded during 1985 with 51376 cases and thereafter declined to 31126 in 1987 and increased to 34400 in 1988 and 45622 cases in 1989 with 2542 *P. falciparum* cases.

The transmission of malaria in Madras city is perennial and the peak transmission period is between July/August and October/November. The city comprises of 150 municipal corporation divisions. Table 3 provides information on stratification according to the Annual Parasite Incidence (API). It is apparent that during the period 1985-1989 the total number of divisions exhibiting more than 20 API ranged between 12 and 29. Such divisions which were 12 in 1987rose to 14 in 1988 and to 19 in 1989. The population of these divisions having an API of 20 and above ranged from about 3 to 7 lakhs. The density of population/sq.km. ranged from about 30000 to 50000 over the 5 year period.

TABLE 3 : CLASSIFICATION OF CORPORATION DIVISIONS ACCORDING TO API

Classification details	1985	1986	1987	1988	1989
I. API 20+					
Number of divisions	29	17	12	14	19
Population (lakhs)	6.78	4.06	2.84	3.56	5.07
Density of population/sq..km.	37088	29882	32847	48263	44840
II. API 11-19					
Number of divisions	21	26	11	17	20
Population(lakhs)	4.86	6.39	2.9	3.97	4.97
Density of population/sq.km.	20793	34607	35060	32998	27629
III. API 2-10					
Number of divisions	70	68	61	50	48
Population(lakhs)	17.03	16.55	15.51	12.38	11.89
Density of population/sq.km.	18312	18655	20111	34282	21774

Source : Madras Corporation.

The total number of divisions having an API between 11 and 19 ranged from 11 to 26. In this category, there has been a gradual increase in the number of divisions from 11 in 1987 to 20 in 1989. The population of the divisions having an API of 11-19 ranged from about 3 to 5 lakhs. The density of population/sq.km. ranged from about 21000 to 35000.

A total of 48 to 70 divisions fall under the category of 2- 10 API range. Only in this group, a decline in the number of divisions falling under this API range was noticed; from 70 in 1985 to 48 in 1989. The population ranged from about 18000 to 34000.

Although about 35 divisions could be classified as coastal a total of 17 divisions touch the sea. These divisions are 4, 5, 6, 11, 12, 14, 50, 88, 89, 97, 98, 130, 131, 135, 136, and 150. The population is about 4 lakhs.

The API of these divisions for the period 1985-1989 fluctuated from 11.1 to 21.3. Of these divisions, the incidence of the disease is higher in division 6, 11, 12 and 50. The former three divisions have a predominantly fisherman population. Malaria has taken deep roots in the old residential areas on the coastal line, and 16 divisions could be classified as high risk areas. These divisions are 6, 11, 12, 14, 15, 47-57. Of these, the contiguous divisions 47-57 happen to be the major business centre of the city with maximum movement of labour population. Though division-wise stratification of API for the period 1985-1989 has shown that there has been a decline in the number of divisions with 20 and above over the period from 29 in 1985 to 19 in 1989, it has become difficult to obtain a real epidemiological picture as the malaria cases recorded by private medical practitioners in the city are not known. Whatever it may be, it becomes evident that active foci of the disease persists in about 17 divisions of the coastal belt. These divisions also contribute to the bulk of *P. falciparum* cases of the city.

The Slum Clearance Board (SCB) and the Housing Board are two government agencies engaged in the construction of building/flats in the city. While majority of SCB buildings are constructed in the old city area, the Housing Board has constructed buildings mainly in the extensions. The SCB has constructed tenements for the lower income group population including fishermen. The activity of SCB started in 1972 and till now about 50000 housing units have been constructed. Of these, about 30% of the tenements are located in north Madras area. The overhead tanks in the SCB tenements get water supply rarely and hence are left without use. Most of the overhead tanks are in dilapidated condition. These OHTs become nurseries for mosquito breeding as soon as monsoon starts because of stagnant rain water. Hence the community living in and around most of the slum board tenements suffer from malaria out-

breaks year after year. The Housing Board though has constructed flats for high and middle income group category, it also has flats for low income groups. So far the Housing Board has constructed about 66000 units. The overhead tanks in some of the buildings have been closed. Malaria incidence in Housing Board flats is relatively less as compared to SCB. Malaria in Housing Board areas is mainly due to labour. In one such case in Anna Nagar area 51 out of 53 cases recorded in the Central Revenue Quarters were from construction labour.

3. Mosquitogenic potential : The estimation of mosquitogenic potential of a city needs a thorough enumeration of different types of breeding sites for anophelines and culicines. For a city like Madras, where expansion has become a daily process modification of old buildings, and close monitoring should be established to record the creation of new breeding sites during the construction stage of buildings and thereafter and data updated periodically.

3.1 Anophelines : The anopheline breeding potential in an urban area could be estimated without difficulty as the breeding sources are well known, i.e. the clear water bodies such as overhead water tanks, wells, cisterns and rain water collections. The vector of urban malaria (*Anopheles stephensi*) breeds mainly in open overhead tanks and wells. The number of overhead tanks, wells and cisterns per house could be considered as on of the direct methods to measures intensity of anopheline breeding in a division. Keeping this in view, the intensity of breeding was grouped into the following categories.

a) One each OHT, well and cistern for less than 500 sq.mt. surface area (High)

b) One each OHT, well and cistern for 501 - 1000 sq. mt surface area (Medium)

c) One each OHT, well and cistern for 1001 - 1500 sq. mt surface area (Moderate)

d) One each OHT, well and cistern for more than 1501 sq. mt surface area (Low)

Based on this classification, divisions having one each overhead tank, well and cistern for less than 500 sq.mt area considered as areas with high anopheline breeding potential. When this data is transferred on the city map division-wise, it becomes evident that there are three major groups of areas having high anopheline breeding potential. The first group of such divisions is on the northern coastal line, the second on southern coastal line and the third on the south-west region. Altogether there are 64 divisions of the corporation with a population of 15,66,000 which comes under high anopheline breeding potential. It is noteworthy to mention that areas with high incidence of malaria correspond to the areas having one anopheline breeding sources in less than 500 sq. mt surface area (Fig. 6).

The Annual Parasite Incidence for the years 1985-89 in the areas having one anopheline breeding sources for less than 500 sq.mt. area was 16.82, 15.0, 11.6 , 11.6 and 14.7 respectively. Interestingly, the API reduces gradually with the corresponding decline of anopheline breeding sources i.e., one sources for 501 - 1000 sq. m. 1001 - 1500 sq.mt area and so on. According to the category of one OHT, well and cistern, for 501-1000 sq.mt., surface area the API was 7.78, 6.3, 4.4, 3.9 and 5.02 for the period 1985-89 respectively. In the group 1001 - 1500 sq. mt surface area for one OHT, well and cistern, there are 18 divisions with a population of 541900 The API fluctuated between 8.18 (1985) and 3.6 (1987), Table-4

It is important to note that the anopheline breeding potential is gradually increasing in the south-west region of the city. There are 14 divisions having an OHT, well and cisterns in less than 500 sq.mt area. The disease has entrenched itself in the coastal belt and the south-west region will also pose a serious problem in future if suitable measures are not undertaken early.

However if 7-point action plan is implemented to cover all divisions of Madras city it would bring about effective control of

TABLE 4 : STRATIFICATION OF MADRAS ACCORDING TO BREEDING SOURCES

Particulars	ONE ANOPHELINE BREEDING SOURCE IN (Sq.m)				
	< 500	501 - 1000	1001 - 1500	1501 - 2000	> 2000
Number of divisions:	64	40	18	14	14
Population: (in lakhs)	15.66	10.84	54.19	40.16	37.64
API:					
1985	16.8	7.67	8.18	7.55	.6.8
1986	15.07	6.26	5.27	4.14	4.6
1987	11.56	4.4	3.6	3.64	3.47
1988	11.57	3.86	4.35	4.65	2.9
1989	14.7	5.02	5.46	5.32	4.83

Source : Madras Corporation

Anopheline and Aedes breeding in OHTs, wells and cisterns and thus produce dramatic results in transmission.

3.2 Culicines- (i) *Aedes* : Based on field experience only cisterns have been considered as potentially high *Aedes* breeding habitats. One or more *Aedes* positive cistern per 10 houses was used for estimating the degree of *Aedes* output in a division. When this data is transferred on a map of the city, the high potential *Aedes* breeding areas fall into three regions; a) north and north-west fringe, b) south-west and south fringe and c) northern portion of the coastal strip (Fig. 7). Of the 150 divisions of the city, 32 divisions (21.3%) have one or more number of cisterns per 10 houses.

(ii) **Culex**: Within the city, the breeding of culicines, particularly that of *Cx. quinquefasciatus* in confined to the storm water drains, although other water bodies such as Coovam, Adayar, Otteri Nalla and Buckingham canal contribute to the breeding of this species. The storm water drains meant to carry rain water have become

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ready to use dust bin for dumping garbage. As a result of chocking of drains the rain water instead of flowing gets collected in all low lying areas and borrow pits to serve as breeding ground for *Cx. quinquefasciatus* mosquitoes.The waterways are not properly maintained and as a result extensive breeding of *Cx. quinquefasciatus* occurs in pockets located at the edges extending several kilometers. The same problem has been noticed in Adayar river. If the sand bar formation is not removed systematically at regular intervals, the mouth of the river Adayar gets closed by sand bar formation leading to extensive breeding of *Cx. quinquefasciatus* in upper reaches of the river.

The condition of either the Buckingham canal or Otteri Nallah is not much different then in Coovam and all these waterways carry sewage water.

The localities such as Saidapet, Kodambakkam, Vadapalani located on the south-west and west divisions of the city had high mosquitogenic potential for *Cx. quinquefasciatus* mosquitoes, when they were extended areas of the city. However with the improvement of sewage disposal system the present *Culex* mosquito production is not that high as it used to be.

The divisions which are considered as potential areas for culicines breeding have been mapped. This is mainly based on the length of storm water drain and other supporting water bodies which are congenial for the breeding of *Culex quinquefasciatus.*

As far as culicine mosquito breeding is concerned, it is difficult to establish a parameter for the intensity of breeding as many sites may remain obscure, e.g., partially covered drains etc. Therefore unless adult mosquitoes and larval density is monitored regularly in every division and potential breeding sites mapped, no realistic estimate could be made. However all divisions having more than 2000 mt. length of storm water drain and more than 500 soak pits and cesspools/pits have been grouped as high *Culex* potential areas. If

this parameter is applied, there are 72 divisions with high *Culex* mosquito potential (Fig. 8), and the number of such divisions are almost equally divided between north and south Madras i.e., 38 and 34 divisions respectively. The *Culex* breeding potential is high in the divisions adjoining the extended areas of the city in the north and west. Further, the divisions lying on either side of Coovam river have a higher *Culex* mosquitogenic potential compared to the divisions adjoining Adayar river. Out of 25 corporation divisions through which the river Coovam passes, almost all divisions except one belongs to high *Culex* breeding potential. Whereas out of the 9 divisions touching Adayar river, only one division could be classified as high *Culex* breeding potential.

4. Mosquito breeding in Extended areas :There are 13 areas lying outside the city limits under the respective municipalities. All these areas are highly productive for mosquitoes, both anophelines and culicines.

4.1 Anophelines : When *A. stephensi* happens to be the major vector in the city, some of the extended areas are under the influence of *A. culicifacies.* The breeding of *A. culicifacies* in brick kilns from Tiruvottiyur to the outskirts of divisions 33 and 76 i.e., Padi and Nerkunram is of epidemiological importance. *A. culicifacies* is the major species. As per the available estimates there are about 200 brick kilns operating with about 150-200 people camping on the site. The labour is mainly from Tirunellveli, Ramanad, North & South Arcot districts. They arrive here by January and leave the site by June/July. It may be pointed out that the monsoon activity generally ceases by December and the water accumulated in the kiln pits becomes ideal breeding site for *A. culicifacies.* With the arrival of labour from southern parts of Tamil Nadu, a few being gametocyte carriers, it may not take much time to trigger focal outbreaks of malaria in the presence of build-up of *A. culicifacies* densities. A few focal outbreaks of malaria have been reported in the past from these brick kiln areas mainly due to *A. culicifacies.*

There are ricefields both within and outside of division 76 and 33. Although larval samples have not been collected to determine the breeding of anophelines and culicines it is likely that this habitat supports breeding of *Cx. tritaeniorhynchus,* one of the members of *Cx. vishnui* complex and a recognised vector of Japanese encephalitis.

4.2 Culicines : All extended areas of this city have a high culicine breeding potential. This is mainly because of a large number of soak pits, improper drainage system, rain water collection etc. In some areas the sewage is being let into drains directly which is not uncommon in the Alandur Municipal limits. In these areas, drainage is the major problem. In sample surveys carried out by conducting adult and larval surveys in Madhavaram area, in addition to *Cx. quinquefasciatus* Mansonoides and *Cx. gelidus* were recorded. In the larval surveys carried out in soakage pits in Madhavaram area the pupal density of *Cx. quinquefasciatus* was found as high as 126/dip (dipper of 60 ml. capacity). Collection of *Cx. gelidus* from the outskirts of the city assumes importance as this has been suspected as a vector of Japanese encephalitis. The collection of *Mansonia* sp. from Madhavaram is also of great importance as this area is inhabited by a large number of people from Kerala State which has one of the longest tracts of *Brugia malayi* infection. In the presence of *Mansonia* sp. mosquitoes (vector of *B. malayi* filariasis infection), a few imported mf carriers from *B. malayi* area of Kerala State may lead to the establishment of *B. malayi* foci in the area.

5. Malaria at Construction sites :The major construction works undertaken in the city has drawn and is drawing people from different parts of Tamil Nadu. In some of the construction sites, labour takes shelter near the site itself. As a number of storage water tanks are constructed for curing cement pillars etc., *A. stephensi* breeds profusely and transmission continues. Apart from this people residing in the adjoining slums also get infected. The MMDA building in Egmore which was recently completed could be cited as an example. There were about 200-300 labour from Salem and all of them

were camping on the construction site. Adjoining this building there is a slum called Jyotiammal Nagar which has a population of about 1000. This slum comes under division 86 which is one of the experimental areas of the Malaria Research Centre. During the Mid 1987, a large number of cases started appearing from this slum. On investigation it was revealed that most of the slum dwellers work in this construction site, and among the labour which came from Salem, 115 were found positive out of 335 blood smear examined. It was therefore evident that not only the labour camping in the premises were infected but also the slum dwellers. It is also likely that some of the slum dwellers might have been infected in the slum itself as the distance between the building and the slum is just about 200 meters. Therefore it is of paramount importance to implement adequate preventive and corrective measures at the construction sites.

The corporation division 53-55 happens to be a centre of business activity in the city of Madras. The main vegetable market is located here and almost all transport companies operate from this area, and therefore labour congregation is maximum in this division. Most of the labourers take their food and also sleep in these dhabas (eating place) on contract basis. There are about 10-15 such places located on different roads. In a survey carried out during 1987, it was found that about 1000 labour from Trichi, South and North Arcot district were working and living in this peculiar manner and thus exposed to infection.

6. Krishna Water Project : The acute shortage of drinking water in the city necessitated the government of Tamil Nadu to come to an understanding with the government of Andhra Pradesh for the supply of water through an open channel from Krishna river. The state of Tamil Nadu would draw about 15 TMC of Krishna Water from Srisailam reservoir from July to October. The water is supplied through an open lined channel which runs for 24.5 kms. inside Tamil Nadu and feeds the already existing reservoirs i.e., Poondi, Chen-

barabakkam and Red hills. Already about 60% of the canal work has been completed.

The work of this magnitude necessitates recruiting a large labour force who will be housed in temporarily built huts during the construction period. Malaria is the major disease. The canals during the construction stage and borrow pits permit accumulation of rain water thus providing opportunities for *A. culicifacies breeding.* After completion of the project, the seepage water collections, depressions on the sides of the canal become sources of breeding for *A. culicifacies* leading to malaria transmission.

To control malaria in Madras city a 7-point action plan is given at the beginning of this document. The implementation of this action plan would result in malaria interruption, control of dengue and reduction in mosquito nuisance and all this would be possible within the available resources of the Madras corporation and the collaborating agencies.

Printed at Akashdeep Printers, New Delhi-2